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Optical range hosts world-class research

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KIRTLAND AFB, N.M. — Atop a 6,000-foot peak in the southeastern portion of Kirtland AFB, N.M., is the Starfire Optical Range where the world's premier adaptive optics telescope is housed. Capable of tracking low-earth orbiting satellites, here is where technologies were pioneered that allowed astronomers to see space objects clearly through the distorting effects of the atmosphere.

Starfire Optical Range maintains a telescope with a 3.5-meter-diameter (11.5 feet across) primary mirror, which is protected by a unique retracting cylindrical enclosure that allows the telescope to operate in the open air.

Using lasers, a sophisticated computing capability and adaptive optics, the telescope is able to distinguish basketball-sized objects at a distance of 1,000 miles into space. This world-class optical research facility is the center for Air Force strategic optical research. Starfire's primary mission is to develop optical sensing, imaging, and propagation technologies. It is a major component of the Air Force Research Laboratory's Directed Energy Directorate.

The lightweight, honeycomb-sandwich primary mirror weighs 4,500 pounds and has a one-inch-thick glass facesheet. The surface is precisely polished to 21 nanometers, or 3,000 times thinner than a human hair. There are 56 computer-controlled actuators behind the mirror to maintain its shape while the telescope is moving.

A unique feature of the 3.5-meter telescope is its protective enclosure: Its "walls" consist of three 70-foot-diameter, 9-foot-high cylinders, aligned on top of each other to resemble a large can. These cylinders retract – an operating mechanism that resembles an inverted collapsible camping cup. As the cylinders drop around the telescope, the telescope "looks out" through a 35-foot-diameter shuttered opening in the roof.

This enclosure has two major advantages over conventional telescope domes that are equipped with narrow slits: the enclosure does not have to be rotated at high speed for satellite tracking, and it improves image quality by releasing warmer "trapped" air that could create optical distortions.

The combined weight of the telescope, gimbal, optics, and support structures exceeds 100 tons. The telescope sits on a massive, steel-reinforced concrete pier that weighs more than 700 tons and which is isolated from the rest of the facility and anchored in bedrock with long steel rods.

Thermal control of the telescope and facility is essential to obtaining high quality images. A unique feature of the 3.5-meter facility is the removal of heat by a closed-cycle water system chilled by a large "ice house" located a quarter-mile from the telescope. In the daytime, ice is made and stored in an underground pit for use at night. A 30-foot pit beneath the floor of the physical plant can hold 4.5 million pounds of ice. Propane-fired boilers can generate up to 2 million BTUs for hot water, which is also supplied to the 3.5-meter facility. Very precise temperature control of optical labs and equipment can be achieved by mixing the right proportions of hot and chilled water, which then conditions air and equipment in the facility. Unlike conventional air conditioning systems, this method prevents heat from being released into the air near the telescope.

Total cost of the 3.5-meter telescope, enclosure, laboratories, physical plant, and all supporting facilities was $27 million.

The research and operations staff is comprised of approximately 80 military, civilian, and contractor personnel. Included in the staff are physicists, mathematicians, astronomers, electronic and mechanical engineers, optical designers and technicians, sensor and computer specialists, laser technicians, meteorologists, electricians, plumbers, welders and machinists. **@**